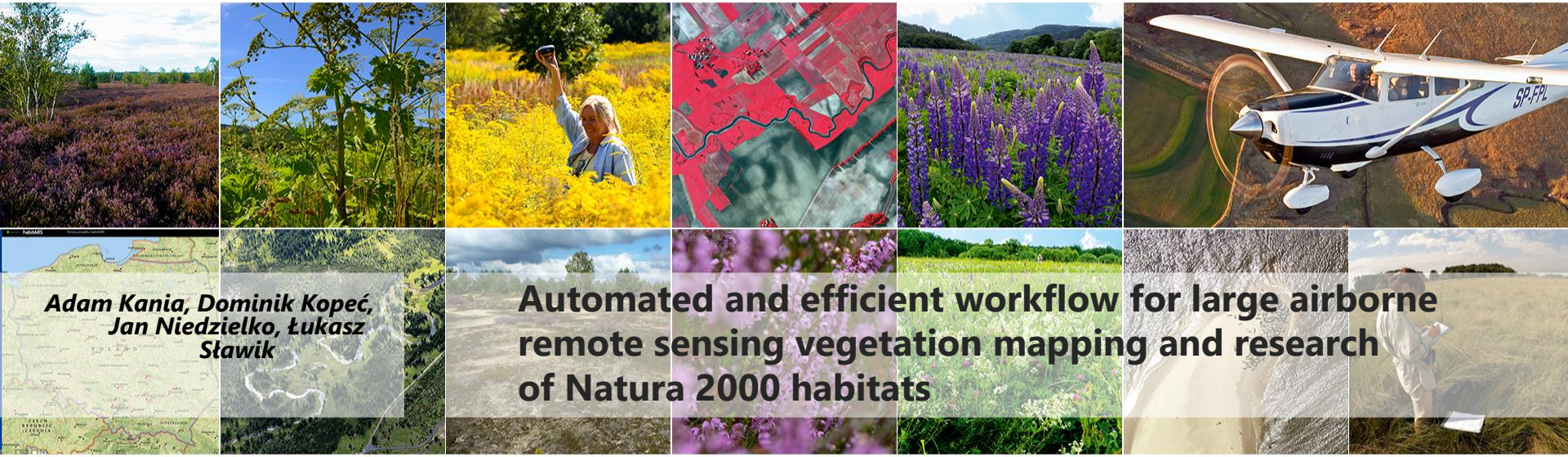
HABITars
Habitats Airborne Remote Sensing



Adam Kania, Dominik Kopeć, Jan Niedzielko, Łukasz Sławik

Automated and efficient workflow for large airborne remote sensing vegetation mapping and research of Natura 2000 habitats

MGGPAERO

Projekt „Innowacyjne podejście wspierające monitoring nieleśnych siedlisk przyrodniczych Natura 2000 z wykorzystaniem metod teledetekcyjnych”,współfinansowany ze środków Narodowego Centrum Badań i Rozwoju, w ramach programu „Środowisko naturalne, rolnictwo i leśnictwo”BIOSTRATEG/Konkurs II.

BIOSTRATEG

Narodowe Centrum Badań i Rozwoju

UNIWERSYTET WARSZAWSKI

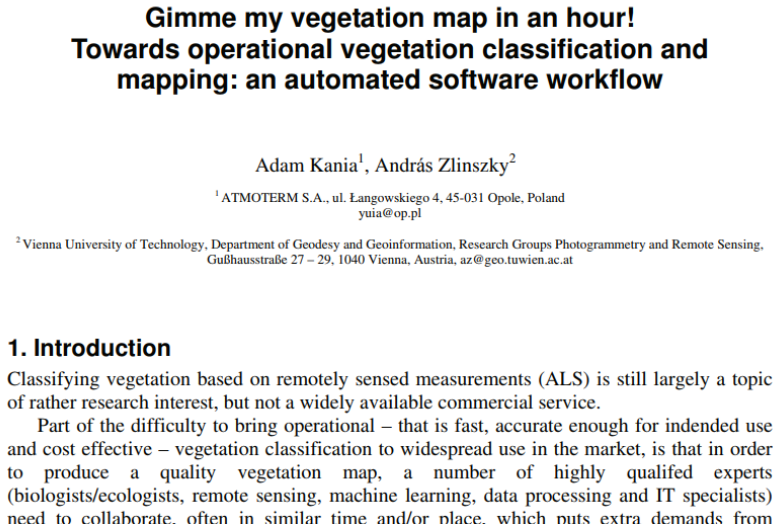
Uniwersytet ŁÓDZKI

UNIWERSYTET ŚLĄSKI W KATOWICACH

INSTYTUT TECHNOLOGICZNO-PRZYRODNICZY

How it all begun

- ChangeHabitats2 project (2011-2015)
- Institut of Photogrammetry, TU Wien, w/András Zlinszky
- First concept that later became Vegetation Classification Studio
- Now developed comercially by **definity**



Gimme my vegetation map in an hour! Towards operational vegetation classification and mapping: an automated software workflow

Adam Kania[1], András Zlinszky[2]

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1. Introduction

Classifying vegetation based on remotely sensed measurements (ALS) is still largely a topic of rather research interest, but not a widely available commercial service.

Part of the difficulty to bring operational – that is fast, accurate enough for indended use and cost effective – vegetation classification to widespread use in the market, is that in order to produce a quality vegetation map, a number of highly qualifed experts (biologists/ecologists, remote sensing, machine learning, data processing and IT specialists) need to collaborate, often in similar time and/or place, which puts extra demands from

Traditional way

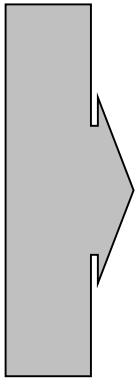
- method
  - sensor data: ALS / HS
  - derived rasters
  - process ground truth data
  - make a model from ground truth polygons
  - validate & quality check
  - apply the model to whole area
  - produce final maps

- tools
  - OPALS / LAStools / ArcGIS
  - ENVI
  - ArgGIS
  - MatLab / R
  - ...

typically no single end-to-end tool to cover the whole process

The alternative

- method
  - point cloud
  - derived rasters
  - process ground truth data
  - make a model from ground truth polygons
  - validate & quality check
  - apply the model to whole area
  - produce final maps



- tools
  - OPALS / LAStools / ArcGIS
  - Vegetation Classification Studio

HABITATS AIRBORNE REMOTE SENSING

The innovative approach supporting monitoring of non-forest Natura 2000 habitats, using remote sensing methods.

The project is realized as part of the BIOSTRATEG strategic program for research and development work „*Środowisko naturalne, rolnictwo i leśnictwo*" [Natural environment, agriculture and forestry] funded by The National Centre for Research and Development in Poland.

An innovative approach

The project develops an innovative approach supporting non-forest Natura 2000 habitats monitoring using remote sensing methods.

The existing methods of monitoring habitats are based on subjective assessments of experts made on location. Information is extrapolated from points to the whole area.

The aim of the HabitARS project is to develop an objective and repeatable method of identification of non-forest habitats and threats to those habitats, such as desiccation, succession and encroachment of invasive alien and expansive domestic plant species, using remote sensing methods and field botanical reference measurements.

1 company & 6 academic institutions

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WARSAW UNIVERSITY OF TECHNOLOGY

ITP

UNIWERSYTET ŚLĄSKI
W KATOWICACH

SZKOŁA GŁÓWNA GOSPODARSTWA WIEJSKIEGO
W WARSZAWIE

WYDZIAŁ BIOLOGII i OCHRONY ŚRODOWISKA

VERITAS ET LIBERTAS
UNIVERSITAS LODZIENSIS
Uniwersytet ŁÓDZKI

Teams

- 81 persons
- Botanists, remote sensing, hydrology, cartography scientists, pilots/flight engineers



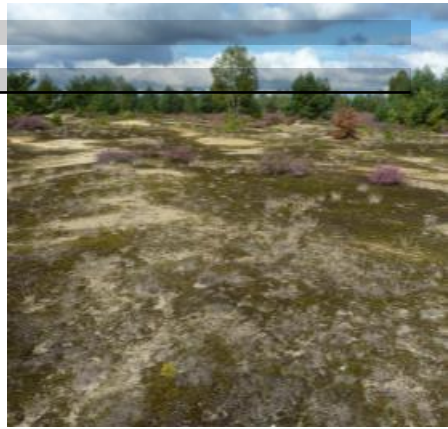
Some selected botanical aspects…

11 protected Natura 2000 habitats

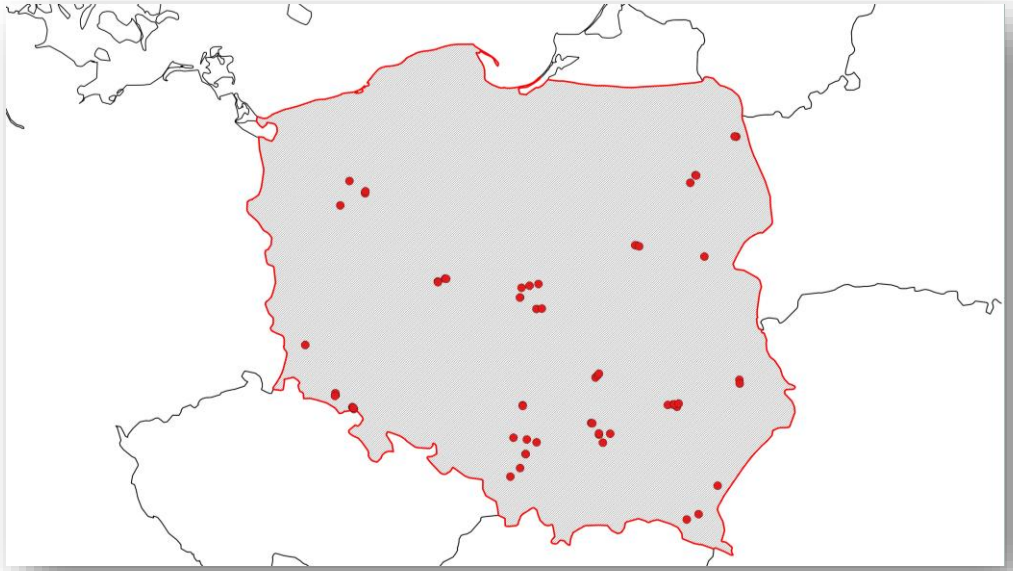
No.	Habitat type	Habitat cod
1	Inland salt meadows	1340
2	European dry heaths	4030
3	Xeric sand calcareous grasslands	6120
4	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	6210
5	Species-rich Nardus grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe)	6230
6	Molinia meadows on calcareous, peaty or clayey-siltladen soils (Molinion caeruleae)	6410
7	Alluvial meadows of river valleys of the Cnidion dubii	6440
8	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	6510
9	Mountain hay meadows	6520
10	Transition mires and quaking bogs	7140
11	Alkaline fens	7230

18 alien and native invasive species

No.	Alien invasive species
1	Echinocystis lobata
2	Erigeron annuus
3	Heracleum spp. (H. mantegazzianum, H. sosnowskyi)
4	Lupinus polyphyllus
5	Padus serotina
6	Reynoutria spp. (R. ×bohemica, R. japonica, R. sachalinensis)
7	Robinia pseudoacacia
8	Rumex confertus
9	Solidago spp. (S. canadensis, S. gigantea, S. graminifolia)
10	Spiraea tomentosa
No.	Native expansive species
1	Calamagrostis epigejos
2	Cirsium arvense
3	Deschampsia caespitosa
4	Filipendula ulmaria
5	Molinia caerulea
6	Phragmites australis
7	Rubus spp.
8	Urtica dioica



Study sites



2016

Botanical reference polygons: 22 633
23 study sites: **2090** km2
Flight hours: 302.86 h

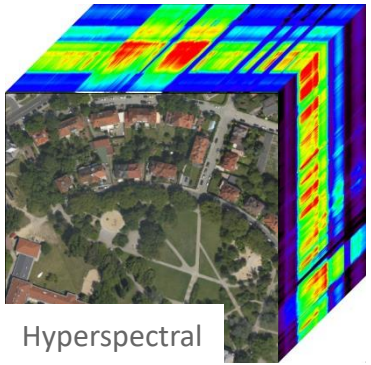
1 campaign: 01.05.2016–30.06.2016
2 campaign: 01.07.2016–31.08.2016
3 campaign: 01.09.2016–02.10.2016

2017
Botanical reference polygons: 22 807
19 study sites: **1216** km2
Flight hours: 187.56 h

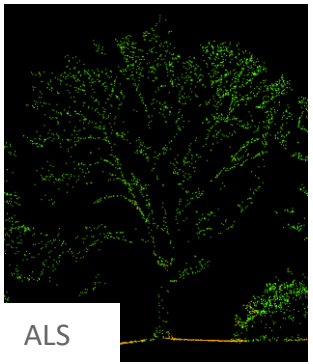
4 campaign: 15.05.2017–27.06.2017
5 campaign: 07.07.2017–24.08.2017
6 campaign: 09.09.2017–29.09.2017

Integrated sensor platform – all sensors' data acquired simultaneously (same timing, geometry, synchronized angles)

High-res RGB



Hyperspectral



ALS

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Aerial data collection from integrated acquisition platform

Cessna 402B

Kamera Intergraph DMC I
Kamera Intergraph DMC II 230
Kamera Vexcel UC Eagle
Lidar Riegl LMS-Q680i
Kamery hiperspektralne HySpex
Kamera termalna DigiTHERM

Piper PA-31 Navajo

Kamera Intergraph DMC I
Kamera Intergraph DMC II 230
Kamera Vexcel UC Eagle
Lidar Riegl LMS-Q680i
Kamery hiperspektralne HySpex
Kamera termalna DigiTHERM

Wiatrakowiec Tercel

LIDAR Riegl VQ-480i
Phase One iXA 180
Zestaw kamer ukośnych
Kamery hiperspektralne HySpex
Kamera termalna DigiTHERM

Vulcan Air P68 Obeserver 2

Kamera Intergraph DMC II 230
Kamera Vexcel UC Eagle
Lidar Riegl LMS-Q680i
Zestaw kamer ukośnych
Kamery hiperspektralne HySpex
Kamera termalna DigiTHERM

Samolot ultralekki KR-030 Topaz

LIDAR Riegl VQ-480i
Phase One iXA 180
Zestaw kamer ukośnych
Kamery hiperspektralne HySpex
Kamera termalna DigiTHERM

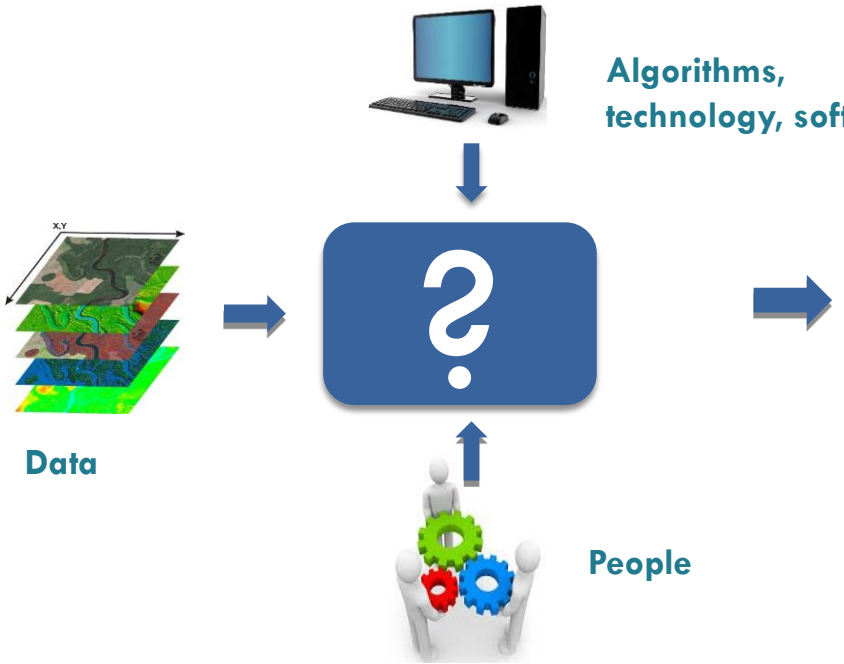
Cessna T206H

Kamera Intergraph DMC II 230
Kamera Vexcel UC Eagle
Lidar Riegl LMS-Q680i
Kamery hiperspektralne HySpex
Kamera termalna DigiTHERM

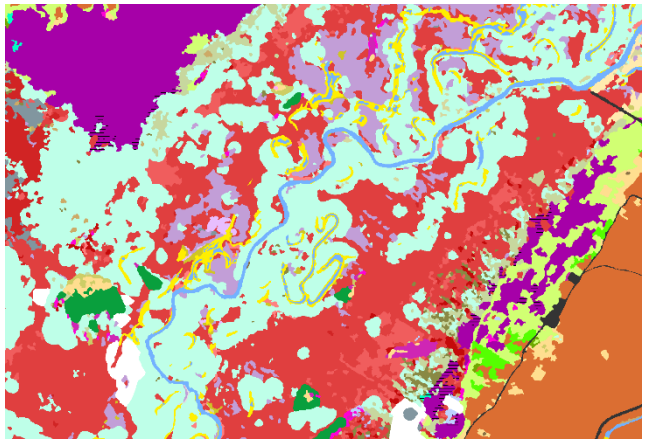
Wiatrakowiec Tercel

LIDAR Riegl VQ-480i
Phase One iXA 180
Zestaw kamer ukośnych
Kamery hiperspektralne HySpex
Kamera termalna DigiTHERM

Job to do – from data analysis point of view



Classifications / vegatation maps



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Classification year 1- state of the art

- result: ~600 classifications made after 1 year by all teams
- manual classification
- standard commercial tools
- no automated workflow

Traditional way

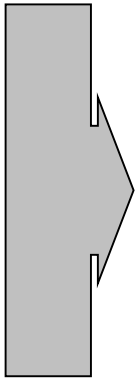
- method
  - sensor data: ALS / HS
  - derived rasters
  - process ground truth data
  - make a model from ground truth polygons
  - validate & quality check
  - apply the model to whole area
  - produce final maps

- tools
  - OPALS / LAStools / **SAGA**
  - ENVI
  - **EnMAP-Box**
  - ArgGIS
  - MatLab / R

make this whole process automated

The alternative

- method
  - sensor data: ALS / HS
  - derived rasters
  - process ground truth data
  - make a model from ground truth polygons
  - validate & quality check
  - apply the model to whole area
  - produce final maps



- tools
  - OPALS / LAStools / **SAGA**
  - Vegetation Classification Studio

Innovation

- Vegetation Classification Studio..
- ..deployed in server version
- central repository of data
- experiment definition language
- (automated sensor data production, error checks, email reporting/notification service)

VCS server version

- runs unattended
- recovers from errors
- can work for long time, days/weeks, unattended
- serves multiple users…
- …and multiple datasets…
- …at once

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central data repository

- remote sensing & botanical data
- 1 place to store everything
- FTP access
- all users / all teams
- consistent structure enforced

experiment definition language

- *(the key our success)*
- YAML
- text based
- human oriented
- computer readable
- *(want anything else?)*

```yaml
# Example experiment definition file (YAML) code BI1 K4

all:
    ++ALS   # include all ALS features
    ++HS    # include all hyperspectral features
    ++IND   # include vegation indexes
    -*pcount    # exclude datasets ending with 'pcount'
    +file[start:stop:step]  # syntax to select from multi-channel datasets
    +BI1_K6_HS_MNF[:10]     # first 10 channels
    +BI1_K6_HS_MNF[10:]     # from 10th channel to last
    +BI1_K6_HS_MNF[::2]     # every other channel
    +BI1_K6_HS_MNF[1,2,5,7,8,9]  # just the selected channel numbers

ref:
    BI1_K6_REF_BOT_DRZ_km_w1: # name of shp/vector file with groun-truth polygons
        clsname: [klasa02]    # attribute with target class/label name
        crossval: [podzial_2] # attribute with cross-validation designations
        trainratio: 0.5       # training ratio to use for automatic sampling

pf:  # Pixel Filtering expressions (training and validation dataset)
    include: "(NDVI > 0.3) and (pcount > 8)" # include pixels fitting expression
    exclude: "deltaZ < 0.0" # exclude points below surface

cls:
    scenario_basic: # name for a classification scenario

    scenario_withoutHS: # another name
        ff:             # with feature filter applied
            --HS        # skip any hyperspectral data

multi:
    count: 50
    trainratio: 0.3  # keep this amount of training data generally...
    trainratio_Bet_pub: 0.5  #...but increase to 50% for Betula class

    render:
        seq: '[:5]'    # render first 5 classifications
        kappa: '[:5]'  # render 5 classifications with best accuracy


rfe:
    render:
        kappa: '[:5]' # 5 classifications with best Kappa accuracy
        seq: '[:8]'   # 1 first feature sets tried
        fc: '[10:20]' # render classifications from 10 to 20 features


tsne:
    pix:
    patch:
    pixpatch:

master: BI1_K6_HS_MNF

user: ARA

colormap:
  Bet_pub:  [204,41,41]
  Aln_glu:  [204,147,41]
  Pin_syl:  [24,89,18]
  Sal_cin:  [115,230,166]

```

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Feature Filter – selecting remote sensing features (rasters)

```
# sample experiment definiton file YAML code BI1 K6
ff:
    ++ALS   # include all ALS features
    ++HS    # include all hyperspectral features
    --IND   # but exclude vegation indexes
    -*pcount   # datasets ending with 'pcount' are not needed
    +file[start:stop:step]  # syntax to select from multi-channel datasets
    +BI1_K6_HS_MNF[:10]     # first 10 channels
    +BI1_K6_HS_MNF[10:]     # from 10th channel to last
    +BI1_K6_HS_MNF[::2]     # every other channel
    +BI1_K6_HS_MNF[1,2,5,7,8,9]  # just the selected channel numbers

```

Reference Data– selecting ground-truth (training&validation) polygons

```
12
13 ref:
14 ····BI1_K6_REF_BOT_DRZ_km_w1:·#·name·of·shp/vector·file·with·ground-truth·polygons
15 ····|···clsname:·[klasa02]····#·attribute·with·target·class/label·name
16 ····|···crossval:·[podzial_2]·#·attribute·with·cross-validation·designations
17 ····|···trainratio:·0.5·····#·training·ratio·to·use·for·automatic·sampling
18
```

Cross-validation target polygon count by class

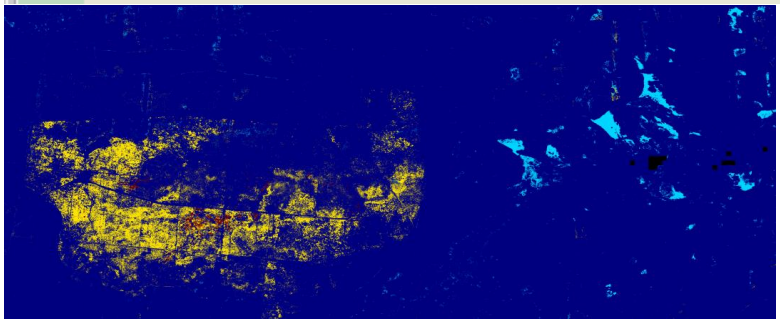
		Polygon count
Class name	**Crossval target**	
4030	**c**	36
	v	223
6120	**c**	13
	v	53
7140	**c**	63
	v	298
9999	**c**	65
	v	359

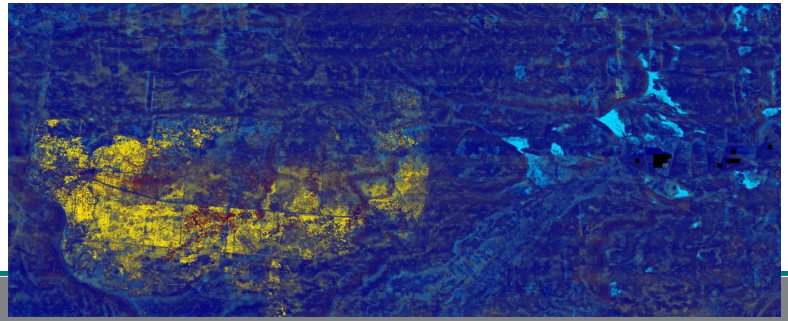
Cross-validation target polygon count totals

	calval
calval	
c	177
v	933

Basic set of classification results & reports

```
22
23 cls:
24     scenario_basic: # name for a classification scenario
25
26     scenario_withoutHS: # another name
27         ff:                 # with feature filter applied
28             --HS            # skip any hyperspectral data
29
```





Classification report

	prec	recall	f1	quant-dis	alloc-dis	support
9999 (1)	.948	.967	.957	.020	.065	10 877
7230 (2)	.926	.906	.916	.022	.144	7 162
7140 (3)	.944	.957	.950	.013	.087	4 445
6230 (4)	1.000	.492	.659	.508	.000	248
Total / Average	**.941**	**.941**	**.940**	**.012**	**.047**	**22 732**
(unweighted)	**.955**	**.831**	**.871**			
Cohen's Kappa	**.906**					

Confusion matrix

	9999	7230	7140	6230	Total	Prod.Acc.
9999 (1)	10521	352	4	0	10877	96.7%
7230 (2)	423	6492	247	0	7162	90.6%
7140 (3)	41	152	4252	0	4445	95.7%
6230 (4)	114	12	0	122	248	49.2%
Total	11 099	7 008	4 503	122		
User Accuracy	94.8%	92.6%	94.4%	100.0%		

Cohen's Kappa: 0.906

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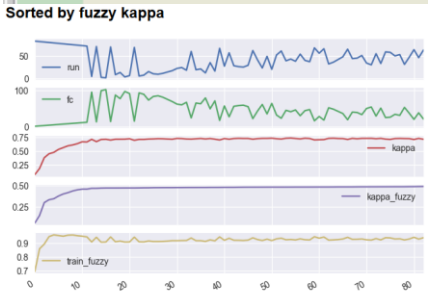
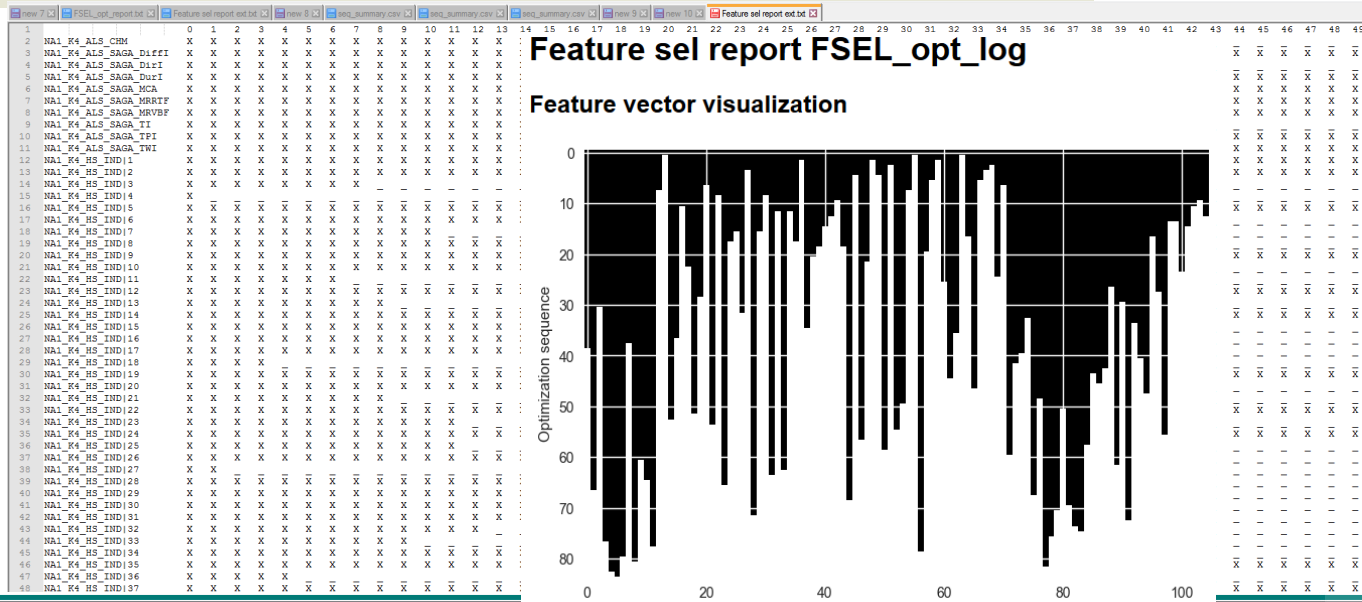
Pixel-level Filter – filtering raster pixels based on attributes & expressions

```
18
19 pf:  #·Pixel·Filtering·expressions·(training·and·validation·dataset)
20 ····include:·"(NDVI·>·0.3)·and·(pcount·>·8)"·#·include·pixels·fitting·expression
21 ····exclude:·"deltaZ·<·0.0"·#·exclude·points·below·surface
22
```

Feature Selection (Recursive Feature Elimination) – with selected renderings selecten according 3 criteria: sequential, feature count, Kappa accuracy

```
39
40 rfe:
41     render:
42         kappa: '[:5]' # 5 classifications with best Kappa accuracy
43         seq: '[:8]'   # 1 first feature sets tried
44         fc: '[10:20]' # render classifications from 10 to 20 features
45
```





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Multiple Classification runs with randomized sampling – with selected renderings, customized sampling parameters

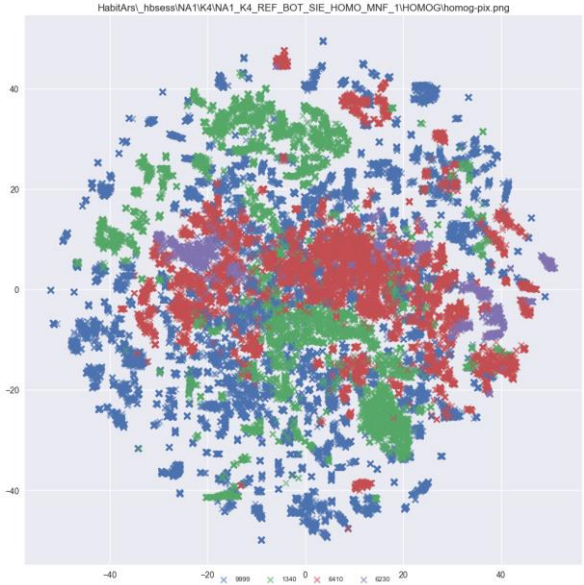
```
29
30 multi:
31     count: 50
32     trainratio: 0.3   # keep this amount of training data generally...
33     trainratio_Bet_pub: 0.5   #...but increase to 50% for Betula class
34
35     render:
36         seq: '[:5]'    # render first 5 classifications
37         kappa: '[:5]'  # render 5 classifications with best accuracy
38
```

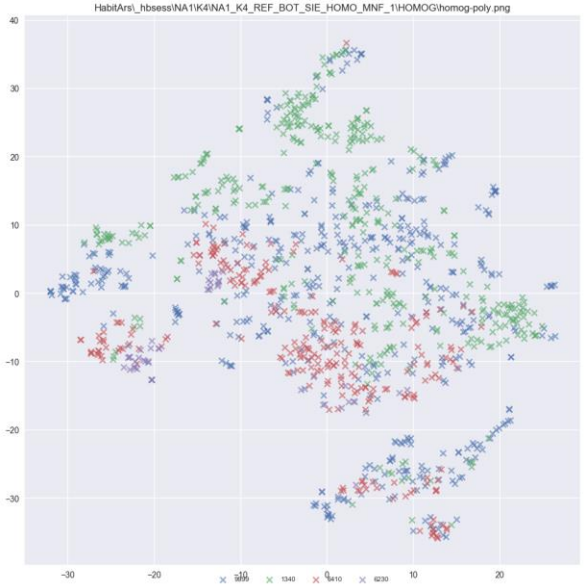
	kappa	kappa_fuzzy
min	0.5889	0.3878
mean	0.6232	0.4149
max	0.6485	0.4301
std	0.0121	0.0094

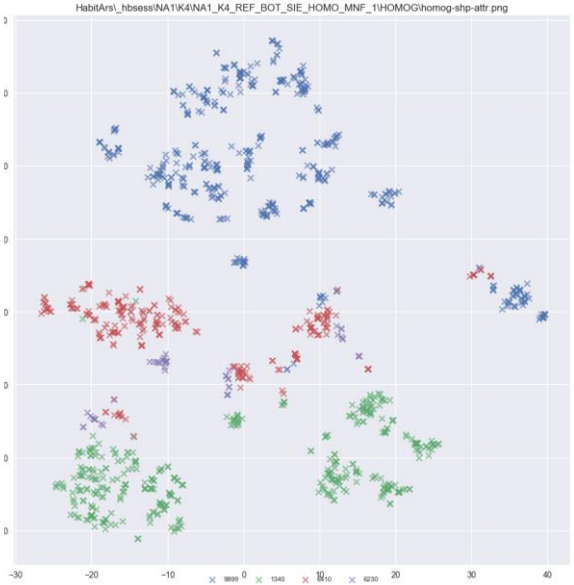
train	train_fuzzy	kappa	kappa_fuzzy
1.0	0.9549	0.6089	0.4059
1.0	0.9524	0.5995	0.4071
1.0	0.9488	0.6292	0.4109
1.0	0.9488	0.614	0.4127
1.0	0.9504	0.6274	0.4283
1.0	0.9543	0.631	0.4266
1.0	0.9554	0.6216	0.4267
1.0	0.9496	0.5889	0.3878
1.0	0.9516	0.646	0.4291
1.0	0.9516	0.6284	0.4214
1.0	0.9477	0.635	0.4186
1.0	0.9533	0.6281	0.4192
1.0	0.9499	0.6098	0.4138
1.0	0.9497	0.6225	0.4243
1.0	0.9499	0.6417	0.4152
1.0	0.95	0.6394	0.4138
1.0	0.9523	0.6337	0.427
1.0	0.9491	0.6378	0.4291
1.0	0.9502	0.628	0.4112
1.0	0.9517	0.6088	0.4078
1.0	0.9538	0.6183	0.4211
1.0	0.955	0.6277	0.4117
1.0	0.9512	0.6307	0.4149
1.0	0.953	0.6275	0.3966
1.0	0.9513	0.6051	0.4038
1.0	0.9458	0.6147	0.4003
1.0	0.949	0.6234	0.4158
0.9997	0.9497	0.6188	0.4009
1.0	0.9535	0.607	0.4261
1.0	0.9493	0.6317	0.4119
1.0	0.9505	0.6009	0.4122
0.9999	0.95	0.6323	0.4034
1.0	0.9524	0.6202	0.415
1.0	0.9524	0.63	0.4179
1.0	0.9483	0.6252	0.4165
1.0	0.9509	0.6118	0.4224
1.0	0.9524	0.624	0.4149
1.0	0.9463	0.6291	0.4063
1.0	0.9462	0.6282	0.417
1.0	0.9479	0.6175	0.4113
1.0	0.9439	0.6166	0.3989
1.0	0.9547	0.6323	0.4301
1.0	0.9506	0.6404	0.43
1.0	0.9518	0.6238	0.4122
1.0	0.9504	0.6235	0.4158
1.0	0.9487	0.6205	0.4137
1.0	0.9484	0.6485	0.4242
1.0	0.9475	0.6198	0.4175
1.0	0.9493	0.6235	0.4195
1.0	0.9528	0.6091	0.4086

tSNE dimensionality reduction analysis – pixel, polygon (ground-truth), and botanical attributes level

```
46
47 tsne:
48     pix:    # tSNE visualization of all reference pixels
49     poly:   # tSNE on whole reference polygons
50     attr:   # tSNE on botanical data attributes only
51
```







HABITars
Habitats Airborne Remote Sensing

Some other settings: master raster for rasterization & output products, user owning the job, color scheme used for mapping products

```
51
52 master: BI1_K6_HS_MNF  # use this for rasterization & output products
53     |    |    |    |    |   # esp. in case of not-exactly-aligned rasters
54
55 user: ARA    # who submitted the job and should be contacted on problems
56
57 colormap: # colors to use for those classes in output maps
58   Bet_pub:  red
59   Aln_glu:  pink
60   Pin_syl:  [24,89,18]
61   Sal_cin:  [115,230,166]
62
```

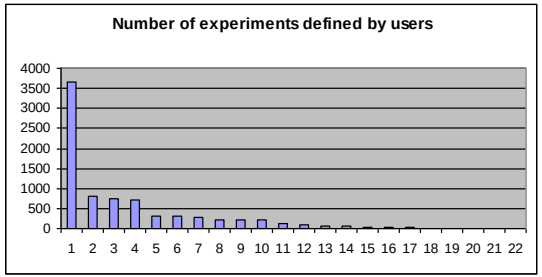
HABITars
Habitats Airborne Remote Sensing

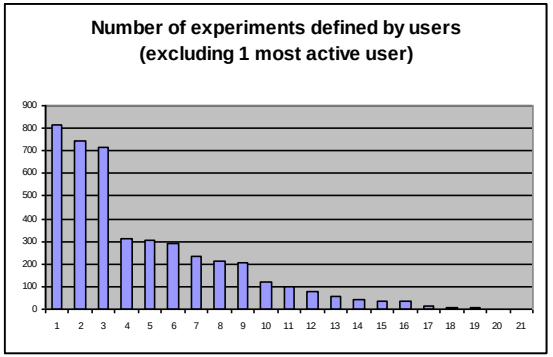
Multi-dataset experiments – designed to work seamlessly with multiple (compatible) datasets / study sites / flights

```
68
69 ff:
70 ····++ALS··#·use·folder·names·if·they·are·consistent
71 ····++HS
72 ····-*pcount··#·partial·name/suffix·matching·same-type·files
73 ····+BI1_K6_HS_MNF[10:]·#·WRONG:·too·specific·file·name
74 ····+*MNF[::2]·····#·better·this·way
75
76 ref:
77 ····#·BI1_K6_REF_BOT_DRZ_km_w1:·#·WRONG:·specific·file·name
78 ····km_w1:·····#·better:·just·suffix
79 ····|···clsname:····[klasa02]
80 ····|···crossval:···[podzial_2]
81 ····|···trainratio:·0.5
82
```

Results in numbers in 2nd year of the project

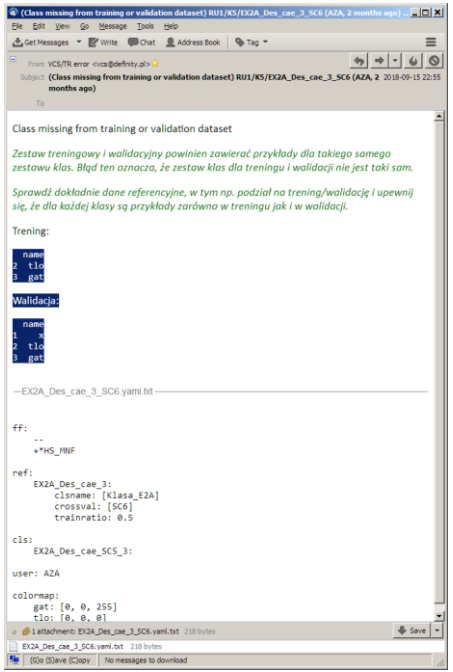
- active users: 21
- experiments defined: 7999
- classification models learned: ~0.49 mln (489 974)
- predictions of whole area: 36 802
- final vegetation maps rendered (incl. color variants): ~100 000





Email reporting/notification service 1

NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w2_p3_v5 (ARA, 56 minutes ago)	VCS user ARA...	2018-09-10 12:48
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w2_p3_v5_spectral (ARA, 55 minutes ago)	VCS user ARA...	2018-09-10 12:47
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w2_p2_v5_spectral (ARA, 55 minutes ago)	VCS user ARA...	2018-09-10 12:47
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w2_p2_v5 (ARA, 54 minutes ago)	VCS user ARA...	2018-09-10 12:46
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w2_p1_v5_spectral (ARA, 48 minutes ago)	VCS user ARA...	2018-09-10 12:40
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w2_p1_v5 (ARA, 47 minutes ago)	VCS user ARA...	2018-09-10 12:39
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w1_p3_v5 (ARA, 47 minutes ago)	VCS user ARA...	2018-09-10 12:39
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w1_p3_v5_spectral (ARA, 47 minutes ago)	VCS user ARA...	2018-09-10 12:38
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w1_p1_v5 (ARA, 40 minutes ago)	VCS user ARA...	2018-09-10 12:32
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w1_p2_v5_spectral (ARA, 39 minutes ago)	VCS user ARA...	2018-09-10 12:30
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w1_p1_v5_spectral (ARA, 38 minutes ago)	VCS user ARA...	2018-09-10 12:30
NI1/K6/NI1_K6_KLA_BAD_DRZ_km_w1_p2_v5 (ARA, 38 minutes ago)	VCS user ARA...	2018-09-10 12:30
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w2_p3_v5_spectral (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 11:14
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w2_p3_v5 (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 11:13
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w2_p2_v5_spectral (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 11:12
NI1/K6/szEXP1_SC02_EX2A_Cal_epi_SC6_20_C (ERA, a day ago)	VCS user ERA,...	2018-09-10 11:10
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w2_p2_v5 (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 11:09
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w2_p1_v5_spectral (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 11:07
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w2_p1_v5 (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 11:06
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w1_p3_v5_spectral (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 11:04
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w1_p3_v5 (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 11:03
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w1_p2_v5_spectral (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 10:59
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w1_p2_v5 (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 10:59
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w1_p1_v5 (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 10:56
NI1/K5/NI1_K5_KLA_BAD_DRZ_km_w1_p1_v5_spectral (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 10:56
NI1/K4/NI1_K4_KLA_BAD_DRZ_km_w2_p3_v5 (ARA, 2 hours ago)	VCS user ARA...	2018-09-10 10:55
NI1/K4/NI1_K4_KLA_BAD_DRZ_km_w2_p3_v5_spectral (ARA, an hour ago)	VCS user ARA...	2018-09-10 10:51



4	Pru_spi	2382163	9.665526
5	Cra_spp	470637	1.909590
6	Cor_san	531401	2.156137

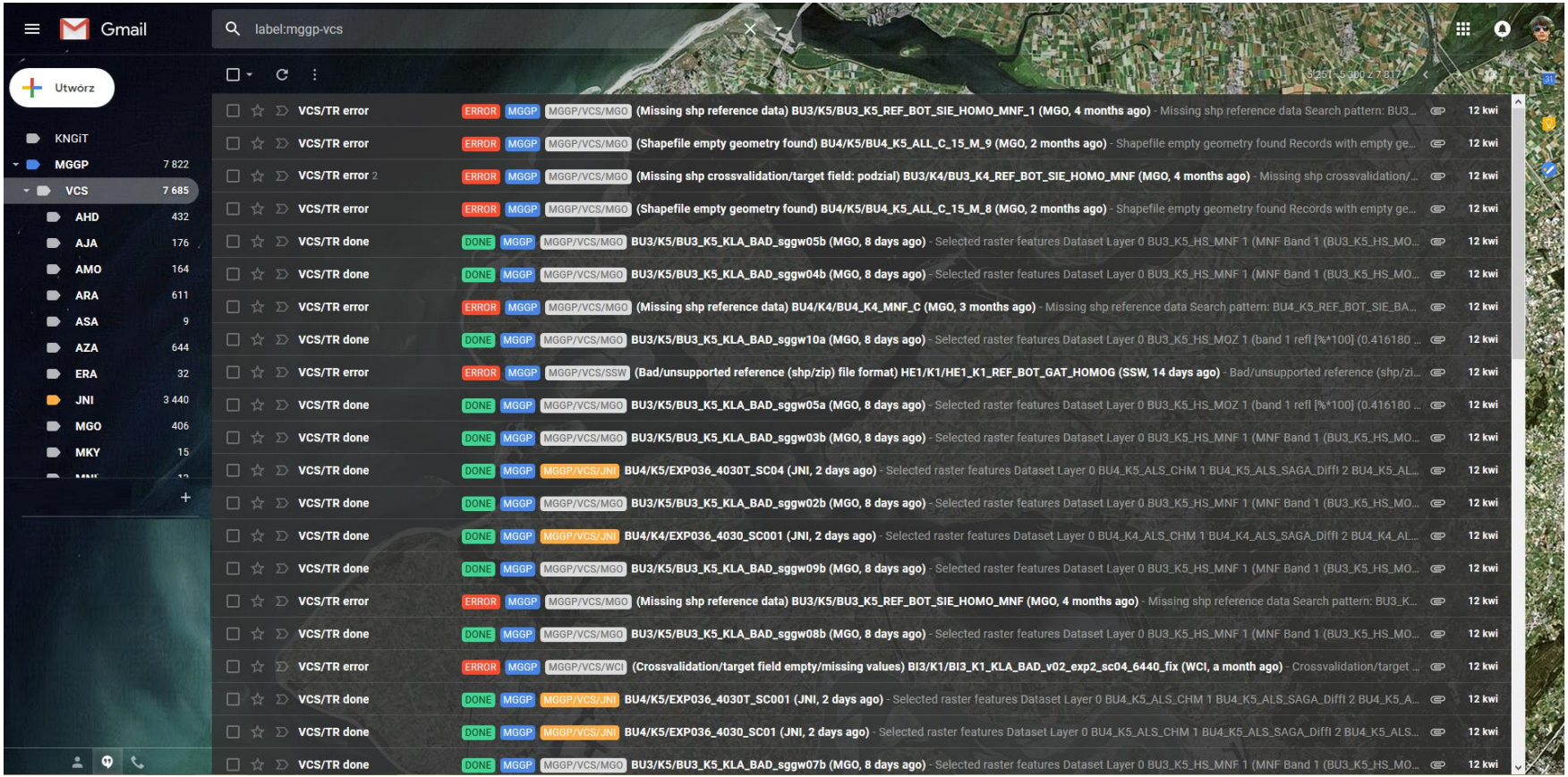
Per-class predicted pixel counts over all models

	class-Cor_san	class-Cra_spp	class-Pin_syl	class-Pru_spi	class-Rha_cat	class-Rob_pse	kappa	model
0	531401	470637	10726356	2382163	1326899	9208519	0.737391	NI1\K6\NI1_K6_KLA_BAD_DRZ_km_w2_p1_v5\RFE\mode...

NI1_K6_KLA_BAD_DRZ_km_w2_p1_v5.yaml.txt

```
# klasyfikacja NI4 K6
ff:
  --
  ++IND
```

Email reporting/notification service 2




… not all can be seen
with remote sensing